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Filed 10/31/2003
Attorney docket no. 1048.002US1

<u>In the claims</u>

1.   (currently amended) A method comprising:

receiving a signal representing digitized, sampled human speech;

locating at least one speech segment within the signal;

locating one or more higher energy sections within each speech segment within the signal;

locating a plurality of glottal events within each speech segment within the signal, based

on the one or more higher energy sections within each speech segment; and,

confirming the plurality of glottal events located within each speech segment within the

signal, including registering each of at least one of the plurality of glottal events with adjacent

glottal events,

<u>wherein confirming the plurality of glottal events located within each speech segment</u>

<u>comprises, for each adjacent pair of glottal events within each speech segment:</u>

<u>comparing a first glottal event and a second glottal event of the adjacent pair of</u>

<u>glottal events to determine a pair-wise distance between the first and the second glottal events;</u>

<u>and,</u>

<u>adjusting boundaries of at least one of the first glottal event and the second glottal</u>

<u>event to minimize the pair-wise distance between the first and the second glottal events,</u>

<u>maximizing similarity of the first and the second glottal events of the adjacent pair, such that</u>

<u>adjusting the boundaries of at least one of the first glottal event and the second glottal event</u>

<u>results in the pair-wise distance between the first and the second glottal events being minimized.</u>

2.   (original) The method of claim 1, wherein receiving the signal representing the digitized,

sampled human speech comprises:

recording human speech; and,

sampling the human speech to digitize the human speech, yielding the signal.

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3.   (original) The method of claim 1, wherein locating at least one speech segment within the
signal comprises determining a start point and an end point of each speech segment.

4.   (original) The method of claim 1, wherein locating at least one speech segment within the
signal comprises determining an energy within the signal and examining the energy for regions
above a threshold, such that each region above of the threshold corresponds to a speech segment.

5.   (original) The method of claim 1, wherein locating the one or more higher energy sections
within each speech segment comprises determining regions within each speech segment where an
energy is at least a percentage of a peak energy within the speech segment.

6.   (original) The method of claim 1, wherein locating the plurality of glottal events within
each speech segment comprises, for each speech segment:

        subjecting each higher energy section within the speech segment to a linear predictive
coefficient (LPC) analysis, yielding a LPC residual error signal for each higher energy section;

        locating a number of largest peaks within the LPC residual error signal for each higher
energy section that have a minimum separation between adjacent of the peaks; and,

        locating the plurality of glottal events within the speech segment as corresponding to the
number of largest peaks within the LPC residual error signal that have the minimum separation.

7.   (original) The method of claim 6, wherein subjecting each higher energy section to LPC
analysis, yielding the LPC residual error signal, comprises, for each higher energy section,
determining the LPC residual error signal as the square of the difference between the higher
energy section and an LPC-derived model of the higher energy section.

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8.   (original) The method of claim 6, wherein locating the number of largest peaks within the
LPC residual error signal that have the minimum separation between adjacent of the peaks
comprises, from all the largest peaks within the LPC residual error signal, removing those peaks
that lack the minimum separation between adjacent of the peaks.

9.   (cancelled)

10.   (currently amended) A computer-readable medium having a computer program stored
thereon to perform a glottal event confirmation method comprising:

        for each adjacent pair of glottal events within each of a plurality of speech segments within
a signal representing digitized, sampled human speech,

                comparing a first glottal event and a second glottal event of the adjacent pair of
glottal events to determine a pair-wise distance between the first and the second glottal events;
and,

                adjusting boundaries of at least one of the first glottal event and the second glottal
event to minimize the pair-wise distance between the first and the second glottal events, such that
adjusting the boundaries of at least one of the first glottal event and the second glottal event
results in the pair-wise distance between the first and the second glottal events being minimized,
        and such that the glottal event confirmation method increases accuracy of subsequently
performed speaker verification methods.

11.   (original) The medium of claim 10, wherein adjusting the boundaries of at least one of the
first glottal event and the second glottal event comprises adjusting at least one of a start point and
an end point of at least one of the first glottal event and the second glottal event.

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12.   (original) The medium of claim 10, wherein adjusting the boundaries of at least one of the first glottal event and the second glottal event maximizes similarity of the first and the second glottal events.

13.   (original) The medium of claim 10, wherein the method further comprises initially locating a plurality of glottal events within each speech segment within the signal.

14.   (original) The medium of claim 13, wherein locating the plurality of glottal events within each speech segment comprises, for each speech segment:

    subjecting each of a plurality of higher energy sections within the speech segment to a linear predictive coefficient (LPC) analysis, yielding a LPC residual error signal for each higher energy section;

    locating a number of largest peaks within the LPC residual error signal for each higher energy section that have a minimum separation between adjacent of the peaks;

    locating the plurality of glottal events within the speech segment as corresponding to the number of largest peaks within the LPC residual error signal that have the minimum separation;

    removing any of the plurality of glottal events within the speech segment that have a zero crossing rate greater than a threshold rate; and,

    removing any of the plurality of glottal events within the speech segment that have a duration outside of a threshold pitch interval range.

15.   (original) The medium of claim 13, wherein the method further comprises, prior to locating the plurality of glottal events within each speech segment:

    locating the plurality of speech segments within the signal; and,

    locating one or more higher energy sections within each speech segment.

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16.   (original) The medium of claim 15, wherein the method further comprises, prior to locating the plurality of speech segments within the signal, receiving the signal.

17.   (currently amended) A speaker verification system comprising:

a computer-readable medium having stored thereon a plurality of first glottal events extracted from previously recorded human speech; and,

a recording device to record further human speech and store a signal representing the further human speech on the computer-readable medium; and,

a mechanism to generate a plurality of second glottal events from the signal, to confirm the plurality of second glottal events by registering each second glottal event with adjacent second glottal events, and to compare the plurality of second glottal events with the plurality of first glottal events to determine whether the further human speech recorded matches the previously recorded human speech, wherein the mechanism is to, for each adjacent pair of the glottal events within each speech segment, each adjacent pair of the glottal events including a leading glottal event and a lagging glottal event, adjust boundaries of at least one of the leading glottal event and the lagging glottal event to minimize a pair-wise distance between the leading and the lagging glottal events, maximizing similarity of the leading and the lagging glottal events of the adjacent pair, such that adjusting the boundaries of at least one of the leading glottal event and the lagging glottal event results in the pair-wise distance between the leading and the lagging glottal events being minimized.

18.   (original) The speaker verification system of claim 17, wherein accuracy of determining whether the further human speech recorded matches the previously recorded human speech is increased by the mechanism confirming the plurality of second glottal events by registering each second glottal event with adjacent second glottal events.

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19.   (original) The speaker verification system of claim 17, wherein the mechanism is a
computer program stored on the computer-readable medium.

20.   (currently amended) A speaker verification system comprising:

    first means for recording human speech and for storing a signal representing the human
speech on a computer-readable medium having previously stored thereon a plurality of first glottal
events extracted from previously recorded human speech; and,

    second means for generating a plurality of second glottal events from the signal, for
confirming the plurality of second glottal events by registering each second glottal event with
adjacent second glottal events, and for comparing the plurality of second glottal events with the
plurality of first glottal events to determine whether the further human speech recorded matches
the previously recorded human speech,
    wherein the means is to, for each adjacent pair of the glottal events within each speech
segment, each adjacent pair of the glottal events including a leading glottal event and a lagging
glottal event, adjust boundaries of at least one of the leading glottal event and the lagging glottal
event to minimize a pair-wise distance between the leading and the lagging glottal events,
maximizing similarity of the leading and the lagging glottal events of the adjacent pair, such that
adjusting the boundaries of at least one of the leading glottal event and the lagging glottal event
results in the pair-wise distance between the leading and the lagging glottal events being
minimized.